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Munnikhuysen, Douglas Y.

George Washington University

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THE GEORGE WASHINGTON UNIVERSITY

A LAYMAN'S GUIDE TO AUTOMATIC DATA PROCESSING

by

Cdr. Douglas Y. Munnikhuysen, USN
Cdr. Richard C. Fay, USN
Lcdr. Robert L. Ghormley, Jr., USN
Lcdr. Emiddio Massa, USN.
Lcdr. George M. Rankin, Jr., USN

of

The Navy Graduate Financial Management Program

Prepared for

Dr. A. Rex Johnson

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PREFACE

The authors, intrigued with the multiplicity of information generated by automatic data processing installations, investigated the field to find a generalized introduction in laymen's language to the problem of computer choice and use. The manufacturers of equipment have so accelerated sophistication that introductory material is generally not available. Educators are developing students along the lines of specific industrial and government requirements and therefore often lack a beginning course of study in Automatic Data Processing Application. Corporate management relies on specialists to prepare feasibility studies and is not informed on elementary material. An introductory paper on this subject does not exist in a form satisfactory to a layman. This thesis is an effort to fill that gap.

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CHAPTER I

THE COMPUTER INVASION

Substantial changes in the business world have created a need for new methods of processing data. Industrial and government business activities are grown to such proportions, that management is unable to secure the information required to control without complexity. Enterprises must have concise, up-to-the-minute information on all aspects of the business to make economically sound decisions. Conversely, as information processing equipment and methods become more sophisticated, new business methods and techniques are developed. Today is a world where data-processing and operations research are part of everyday business life.

Changes in data-processing and management-control methods during the past ten years are the beginning. Later in this paper we shall look to the future with the knowledge that we have only scratched the surface in this changing field. Progress will not make all present systems and control techniques obsolete. It will make knowledge of automatic data-processing essential for all levels of management, those who must rely on facts to make decisions as well as those who need facts to answer questions and

make reports.

History of Processing Data

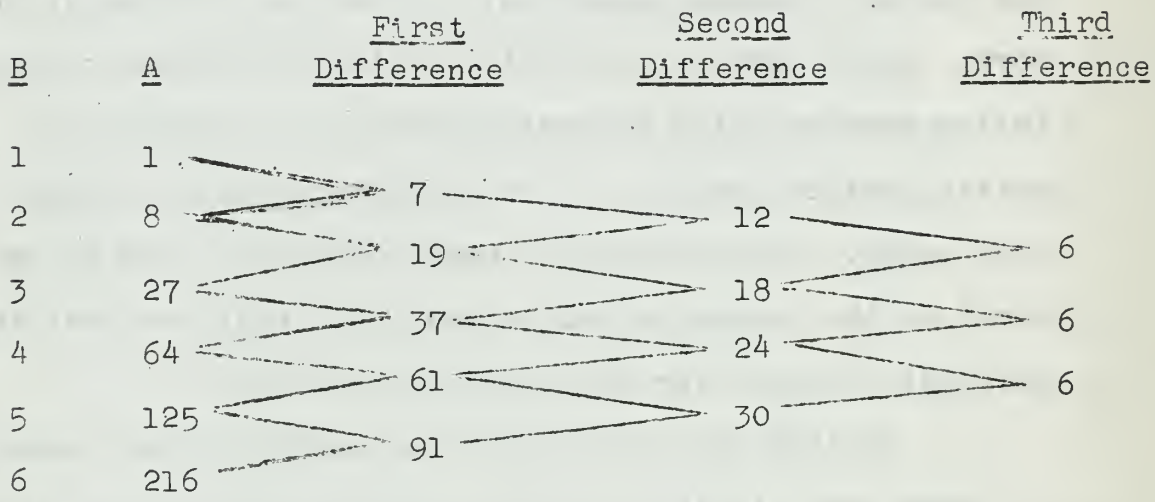
Since the stone age men have been fascinated by mathematics, but bored by the drudgery of it. In those early days, the amount of computation required was relatively small and for the most part could be accomplished by piling stones in a heap or by notching a stick. As the spoken word developed and civilization advanced, so numbers and numbering systems become more important. The development of the decimal system was the real beginning of experimentation in computational devices. Quite naturally, the first of these devices was man's fingers. However, we know there are strict limitations to this device. Since numbers could be represented by fingers, they could be represented by other things as well, and this thought undoubtedly lead to the construction and use of the earliest computer, the abacus. The abacus is nothing more than beads strung in groups of ten. These beads can be moved easily and rapidly and are still in use in many countries today. As a matter of fact, skillful abacus operators can solve problems with such speed that they rival our modern mechanical calculators. The first calculating machine, which was the beginning of our modern machines, was invented in 1642 by Bloise Pascal. This machine consisted of figure wheels, each having the numbers 0 to 9 mounted on parallel axes, to be turned one-tenth to nine-tenths of a complete turn by means of a stylis

or wooden peg. A "carry" device moved the next wheel to the left through one tenth of a revolution as the figure wheel was turned from 9 to 0. This device, modified and improved over the years is still widely sold today as a pocket-size calculator. Also during the seventeenth century, many famous mathematicians such as Basial, Liebnitz and Napier invented mechanical devices to aid them in their work. As an example, Gottfeild Leibnitz invented a calculating machine using repeated addition to perform the multiplication process. This concept is still commonly used today. Unfortunately, these inventions were so far ahead of the technological boundary of their era that they were not utilized for the next two centuries.

By 1885 the world had grown sophisticated enough to accept and utilize an adding machine invented by William Burroughs. This device caught the attention of the business world and soon was being sold on the commercial market. By 1900, the machines multiplied by repeated addition and divided by repeated subtraction. These machines were slow and bulky until around the time of World War I, when the desk calculator was developed.

In 1812, Charles Babbage, studying a table of logarithms, full of mistakes, hit upon the idea of developing a machine to compute these tabular functions. This idea became reality a few years later in the form of a machine called "Babbage's Difference Engine". The underlying concept was that appropriate level differences between the values

computed for a formula are constant, so that the values themselves are obtainable simply by addition. For example, the differences between B^3 in the simple equation $A = B^3$ are as follows:



The third order differences corresponding to the third power of B in $A = B^3$ are constant. Succeeding values of A can then be computed by addition alone. Equations involving higher power of B can be solved in like fashion using a higher order of differences. A version of Babbage's Difference Engine was used in 1863 to calculate life tables for Life Insurance Companies. In conjunction with his difference engine, Babbage attempted to develop an automatic mechanical calculator. He failed in this endeavor, but did lay the design groundwork for our modern day computor. His machine was divided into three parts which he called the store, the mill and the control. The purpose of the store was to hold all the data which would be used during the long computation. The mill did the computation and the

control was to be automatic. The essential components of our present day systems were invented many years ago, but were not exploited until World War II.

The first punched-card machine was developed in the late nineteenth century by Dr. Herman Holerith. He was engaged as a statistician by the U. S. Government to tabulate the 1880 census. The methods utilized at that time were slow and very inaccurate. It took about seven years to complete the operation. To facilitate tabulation, as well as obtain better information retrival, Dr. Holerith invented and developed a punched-card system.

By the time the 1890 census was ready to be tabulated, Dr. Holerith's invention was ready to be tested. The system consisted of 3" x 5" cards divided into 1/4" squares, a punch, a pin press, electromagnetic counters and a sorting box. The cards were punched according to an established code and could be read by placing them over a key card of a different color or by using the pin press attached to the electromagnetic counters. This system could tabulate 50 to 80 cards per minute. The U. S. Government adopted the system to derive the benefits of a faster, cheaper and complete count.

Today's mechanical printers are an outgrowth of the typewriter. In 1843, Charles Tucker invented a typewriter that spaced letters by the use of a movable platen, a feature that still is used. Developments continued and by 1878 a single keyboard typewriter with a carriage shift

was on the market. Electric typewriters in 1920 subsequently led to the development of automatic printing thru electric signals. Now high speed printing of from 50,000 to 100,000 characters a minute is not uncommon.

The invention of the relay after World War I had a great impact on data processing systems. For the first time, it was possible to automatically control these mechanical devices. However, the whole field remained in sort of a state of suspended animation until World War II, when our present day systems became reality. In 1943, the first electronic computer, ENIAC (Electronic Numerical Intergrator and Calculator) was developed at the University of Pennsylvania. This we might say, was the beginning of a new era--Automatic Data Processing.

This brief historical picture, painted with a broad brush, will give us some idea of how the Automatic Data Processing Systems we know today were born. An understanding of the apparently unrelated developments in calculators, typewriters, punched-card systems and computers will clarify the basic functions of data processing.

How's and Why's of Data Processing

As we have seen, men have strived to invent processing equipment which would reduce the human effort as well as provide greater efficiency in the processing of information. Today, Automatic Data Processing (ADP), is part of our everyday business life. Management uses information

which is current, concise and, until recently, was not available in any form.

Before we can investigate a data processing system, we must understand what the term means. Data is defined as facts, information, or intelligence. We use data or information everyday. When you give your name, address or telephone number to a caller, you are communicating data. Today's date, a stock number, a license tag number, all are examples of data.

Data originates in the mind. It is developed, processed, and utilized by man. We all have a definite need for data, unless we desire to live like Robinson Crusoe. When you ask a friend to meet you in town, you say "Meet me on the corner of 14th and F Street at 12:00 noon." In looking at this statement, we see many elements of data: You (understood), me, corner, 14th, F street, and 12:00 noon. Your friend requires this data in order to determine who he is to meet, where he is to meet, and when. You, in this case, are his source of data.

Now that we understand we all use and need data, our next question might be: What is Data Processing? Data processing may be defined as "The preparation of source documents which contain basic elements of information, and the handling of these data to produce records and reports."[1]

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[1]Radio Corporation of America, "An Approach to the Basic Techniques of Systems Analysis."

A source document is the initial entry of data into the system, such as a sales slip or requisition. An element of information (sometimes called an element of data) is a single entry upon a source document. The records and reports produced are the end products of the system and are said to be the result of data processing. In short data processing is the combining of basic information into summary or record form.

Why do we process data? Today business is becoming larger and more complex. Data processing is required to insure all aspects of the business world are taken into account. It is often impossible to have the critical facts available when needed to control operations without data processing. Management must have the current and up-to-date facts about the overall organization in order to properly control the enterprise. Further, management is concerned mainly about areas that are unpredictable, as well as the areas that are not functioning according to the overall plan of the organization. Automatic Data Processing fulfills these requirements. Since management must utilize this information to make decisions, this then is the basic reason for data processing.

Data processing, in and of itself, is not an end. It is only a means to an end. This point must be kept in mind. Management can find little use for source data such as a sales slip. The fact that a customer buys a purple hat, style 466 may have little significance in planning or

controlling of a department store. But if 7,188 purple hats, style 466 have been sold in the last week, this fact then becomes of major importance. Here is a so-called "hot item" which must be taken into consideration, if the store is to take advantage of the popularity of purple hats, style 466. Therefore, we can see that in most cases, data must be handled and manipulated before it is of any value to management. The data processing equipment added up all the sales slips for purple hats, style 466, and came up with some meaningful information for management. Even in this simple example, we can see that if management received this information soon enough to be utilized in their short run planning process, and it was accurate, then we have a good data processing system. Needless to say, if the information was a month old, or if the style was mislabeled on the report, then we have a poor system. Thus, data processing systems can be measured by its responsiveness to management's requirements.

The communication of information is a very important phase of the business operation. The printed word is the most common means of passing information from department to department or company to company. Today much effort is being spent in an area often called "paper work simplification"; that is, the improving of document standardization, preparation and flow. Improvements can be made in this area without making changes in either equipment or organization. Most people assume that when data is collected and

processed that the output is to people. This need can be greatly reduced or even eliminated, when equipment is used for gathering and processing data. The output of the machines at one stage can be the input for the next. Only the results are then required to be put on the printed page.

Automatic Data Processing

Now let's look at just what methods might be used to accomplish some of the things we have been discussing. Data may be processed in any one or a combination of four ways: manually, mechanically, electro-mechanically, or electronically (automatically).

Manual data processing is well known and will not be discussed. The first area of data processing to which tools were applied was arithmetic. The abacus, slide rule, etc., are examples of mechanical tools for processing. The advent of the punched-card gave data processing greater versatility including sorting and printing, as well as arithmetic functions. Today, Automatic Data Processing System utilizes a computer to perform these tasks. ADPS has other features such as speed and general purpose capabilities which set it apart from its predecessors, the mechanical and electro-mechanical devices.

The speed of the electro-mechanical data processor is limited to the speed at which gears can be turned, cards can be moved, or relays can be opened and closed. These systems are limited to those speeds to which physical objects

can be accelerated. The ADPS units can accomplish almost all of its functions through controlling the electrical energy within its circuitry which travels at the speed of light.

Electro-mechanical processors are all special purpose machines. They are designed to do a specific task. For example, cards are passed from machine to machine in the same manner that forms are passed from desk to desk in a manual system. The automatic data processing system is a general purpose machine. It is capable of performing any and all data processing tasks. It handles the entire function, and does not perform the function in a piecemeal fashion. Also, this type of equipment can be programmed to point out a problem area and to supply the recommended solutions.

The heart of the automatic data-processing system is the central processing unit, which is called the computer. The computer has certain functional components which allow rapid data processing. These components are: Input, Storage, Processing unit (arithmetic and logic), Control and Output. Since these terms are rather meaningless, let us see just how our body posseses the same type of components as does a general purpose computer.

Suppose, for the sake of the example, you are standing in front of a stove, and you have no idea as to the stove's use or method of operation. You become very inquisitive, so you reach down and touch one of the red

burners. The first thing that happens is that your sense of touch immediately recognizes a change in temperature. All of your senses including seeing, hearing, smelling, tasting and feeling are your Input devices. The delicate nerves in your fingers send this information through your central nervous system which decides that this impulse is more important than any of the other thousands of impulses received at this instant. Therefore, it routes this priority impulse to the brain. The central nervous system can then be compared to the Control function of the computer. The brain interprets the impulse as one of pain and makes a decision; it sends an order back through the central nervous system to the muscles in your hand. The brain is performing the decision function similar to the Processing unit of the computer. The muscles in this case are serving as the Output. The hand is pulled away rapidly, almost before you really realize that you had touched a hot object. The next time you encounter a stove you will be much more careful about touching it, because at the same time the brain sent the information back to the muscles in your hand, it stored the impulse of pain and fear in a section we call memory. This is similar to the Storage unit of the computer.

The computer can receive input from a keyboard, punched-card, punched-paper tape, or magnetic tape. This input consists of data and instructions which is placed in memory or storage section. This memory device is a magnetic device which can receive, hold or send information. The

instructions now enter the control unit where the proper electrical circuits are energized. According to the instructions, data is acted upon in the processing unit. After the processing has been completed, the new data or information is sent to output section. The output of this system may be in the same form as the input or in printed form. Normally the output of the system is what is required for management control or data which will be used for further processing.

ADP Today

Basically, the machines of today are built to perform many of the routine functions of the brain. They memorize and recall information in a fraction of a second. They recognize spelling, numbers and compare, as well as, associate data. They are able to perform highly complicated mathematical computations which would take in most cases many weeks to perform with any other device. These functions are programmed or built into the system, since to date the machine itself does not have any creative ability or originality.

Many people today are concerned about the rapid advancement we have made in the computer field. Are we putting ourselves at the mercy of these electronic robots? This type of thinking is not new, it also prevailed back in the twenties. Karl Capek, a brilliant Czech playwright invented the word "robot" in his play R.U.R. (Rossum's

Universal Robots). Radius, a bright robot ultimately led a rebellious army of robots which wiped out the human race.

Today's electronic computers are not equal to Radius. However, computer expert, Frank Matthews half-seriously points out,

> Our safeguard is that no matter how intelligent we are able to make computers, we can always reach down and pull out the wall plug. Of course, we will have to make sure we don't supply the computer with an arm that could keep us from unplugging it, and we must not permit it to have an internal power source under its own control.[2]

Today with ADPS we are able to provide management with concise, up-to-the-minute information on all aspects of the enterprise. Today in the eyes of many people if we did not have this capability, our economy would smother in its own complexity. Truly we have reached the point of no return, industry is relying more and more on computers. "If all the computers now in operation caught some electronic disease, it would be a crippling blow, something like national brain fever."[3] We are as dependent on the computer as we are in the automobile or the telephone.

Bell Helicopter has recorded their entire operation of its Dallas plant on tape, so that management is able to ignore most situations except those to which the computer calls special attention. A major Chicago Loan Company utilizes a computer to locate its "deadbeats" that are worth

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[2]Warren R. Young, "The Machines are Taking Over," Life, March 3, 1961.

[3]Ibid.

pursuing for eventual collection. Rayco Manufacturing Company locates its new stores in areas recommended by a computer. In using a computer to keep track of its cars, the Chesapeake & Ohio Railroad so increased efficiency that it was able to cancel a $900,000 order for new flatcars. These are but a few of the many many examples of Automatic Data Processing.

All these present day application paint a bright picture for the future. However, there always remains some fear and doubt. As a computer designer tells the story: A weary programmer who has spent his life tending a computer that always has the right answer for everything finally gets fed up and asks his machine, "All right if you're so smart, tell me, is there a God?" The computer whirs gently, its lights flicker, its coils buzz and humm and at last it clicks out its answer: "THERE IS NOW."[4]

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[4] Ibid.

CHAPTER II

THE ADP ENVIRONMENT

Some considerations concerning the affect of ADP on the human element, management attitudes and the organization.

In a very real way ADP replaces the manual labor and/or the mental effort of man and this cannot happen without having an affect on man himself, the attitudes of management and in the structure and personality of the organization. The sum of these reactions is to create an operating atmosphere or environment which, for our purposes here, we will term the ADP environment. This environment is evident in its psychological impact on the man and in its philosophic impact on the concepts of management.

The Human Element

It has been the experience of management that on the initial installation of a data processing system, initial employee reaction occurs as a result of the "grapevine."[1] During the development and testing of a

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[1]Winston C. Dale, "Getting the Best Results From Simulation," Business Management, October, 1961.

computer model, only a limited number of people can be involved in the details but the fact that such a project is underway becomes generally known throughout the organization by gossip. Since this gossip rarely carries with it any knowledge of the true nature of the project or its ultimate affect on the personnel, their jobs and security, the un-informed personnel in turn become suspicious, anxious and even resentful toward the project. To many people, ADP represents something "foreboding and mysterious and at the bottom of this anxiety is the difficulty in understanding what electronics can do or how it does it."[2] The office worker views the machine primarily as a threat to his job security. This feeling of insecurity is not lessened in many major installations by the appearance of the equipment--all the familiar office equipment is gone; the data center is air conditioned, sound-proofed, painted in modern restful pastel colors and all traces of the old office with its clatter of machines, jumble of desks and clutter of paper are gone. Even the people seem to be subdued and the whole effect is one of sobering impersonality.

The fear of new data processing systems has been found by at least one company to increase in direct proportion to the age of the employee and the number of years he

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[2]Felix Kaufman, "The Effects of EDP on Internal Control," The Journal of Accountancy, June 1961.

has been performing his job.[3] This anxiety appears to stem from not so much a fear of the machine itself but from a fear of losing or changing his hard-won status in the change of organization which he feels will inevitably result from automated methods. That this is not always the case, however, is indicated by the results of a recent study by the American Management Association where it was found that the older workers were more ready to accept the change in three out of the six companies which were surveyed.[4] This same study announced "seven basic reasons for resistance to changes involving office automation." They are:

1. An inept approach by the methods analyst in dealing with others.
2. Over-dependence upon outside methods analysts.
3. Manpower shortage during change-over.
4. Management pressures for quick installation.
5. Lack of participation by supervisory employees.
6. Poor planning for the transfer and reclassification of affected employees.
7. Lack of information about the over-all plan.

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[3] Earl W. Denby, "A Five Year Shift to EDP," The Controller (March, 1960), p. 114.

[4] Report of a study by the American Management Association, "Gaining Acceptance for Major Methods Changes," under "Research Notes," The Controller (August, 1960), p. 390.

It seems clear that the seven points listed above pretty well outline the problem area which may be encountered in the shift to ADP and it appears equally clear that the solution to this problem lies in an effective management communications program and in effective planning throughout all phases of the operation. The key to success, then, is the willingness on the part of top management to go slow and not attempt to complete a complicated project such as the installation of an ADP system in an ill-considered rush.

As indicated earlier, the carefully planned indoctrination of the workers who will be affected is a vital part of the installation process. Actual experience has fairly clearly indicated that for the most part the fears of the workers are groundless. This is particularly true in large corporations where, to begin with, the wholesale replacement of workers has failed to materialize and where worker replacement has been necessary, normal attrition has in most cases solved the problem.[5] As a further illustration, in many cases, the worker who will most likely be replaced is in the category of the young female clerk or secretary. This class of worker has such a high job turnover rate that the normal course of events has made the problem largely disappear.[6] The very nature of the

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[5]A. F. Everman, "Computer-Age Control of Office Costs," The Controller, September, 1961, p. 436.

[6]Previously cited.

data processing system has in some measure, at least, mitigated against these problems because as the equipment begins to operate at anywhere near capacity it becomes virtually a voracious monster in its ability to consume and emit data and thus literally creates the need for jobs on its own. In the same regard, as the usage of ADP goes up--that is, into usage during two and three shifts in order to achieve maximum profit on operation, this again serves to create additional job requirements. It is noteworthy that while the machine requirements tend to actually stabilize or even require additional employees, this comes about without a general increase in the demand for highly trained skills.[7]

The problem of employee retention has taken a different turn in the case of the very small businesses which seek to use ADP. This is the case wherein a highly trusted and well thought of employee with a long record of service is selected for training at the technical school established by the computer manufacturer. If the selection has been made solely on the basis of the employee's esteem in the eyes of the firm rather than his other skills, he very often has turned out to be unsuited for the training required and this, in some cases, has led to some unpleasantness between the contractor and the small business.

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[7] James R. Bright, "Does Automation Raise Skill Requirements?" Harvard Business Review, July-August 1958, p. 85.

However, to repeat, the replacement problem has not turned out to be the problem that it was feared to be. In the cases in which employee replacement or transfer becomes a necessity, moderate and encouraging success has been experienced in the endeavor. Inland Steel, Bell and Howell, and Minnesota Mining and Manufacturing all consider that their employee retraining programs have been successful. International Harvester and Formfit Company have successfully closed plants and either re-located employees or have been successful in finding suitable employment for them elsewhere.[8]

In summary, it is a fact that employee anxiety and possible employee replacement can turn out to be problems but they are not insurmountable if an alert and intelligent management makes an appraisal of the probable trouble areas early in the planning stage of any project and then takes sound action toward employee indoctrination and training through a good communication system.

The Attitudes of Management

"The most serious deficiency in present day computer installations is the general reluctance of managers to think."[9]

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[8] The Controller, March 1960, p. 124.

[9] Navy Management Review, Editorial, September, 1961.

Management attitudes play a provocative role in the success or failure of a modern ADP system installation. These attitudes are manifested commencing with the earliest stages of the initial feasibility study and carry through into the life of the system. Management as it is used here and as will be used throughout the remainder of this section refers to the policy making levels of top executive control. Executives grouped together in this sense are management.

"Executive motivation," says Arch Patton, "thrives on challenge."[10] The advent of an ADP system represents the very biggest sort of challenge that management can face. It is a tremendous challenge in adopting it to the needs of the organization and to developing its use to anything near its capacity. For example, it has been habitual for a large majority of companies to place their computers under the administrative control of the financial section of their organization and this is a very practical place for it. But management must be alert to realize that their computer has many other uses than that of financial control and therefore they must be alert to adapt the routines of computer to overall company usage. At the same time, management must not be beguiled into thinking that computers will run the business; computers merely provide management with more timely and better information on which to make better

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[10]Arch Patton, "The Motivations of an Executive," The Controller, October, 1961, p. 485.

decisions. If computers are allowed to replace executive know-how and experience they can do much to stifle executive motivation and initiative. By relieving executives of many of the petty details of administration, time is made available for creative thought and imagination. Thus data systems now afford a unique opportunity for management to exercise their abilities to an extent heretofore unrealized. It is important to note that the processing ability of today's data systems has generally far exceeded man's ability to utilize them at anywhere near their maximum capability.[11]

There is an in-between area of computer acceptance by management which warrants mention. It has been repeatedly demonstrated in the SAGE installations that Air Controllers who had previously become experienced in Fighter Direction using manual methods on radar plotting scopes were reluctant to accept computer decisions using the fully automated techniques. This general reluctance continued until the operators were forced to realize through repeated experience that the computer decisions were better than his own.[12] Similarly, management should ask themselves how they will react when some of their tried and true business parameters are called into question--and by a machine? Some businessmen can participate readily in the process of progress, but many

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[11] "Planning for an IBM Data Processing System," IBM General Information Manual, 1960. Computer Capacity.

[12] D. G. Malcolm, Alan J. Rowe, edited by L. F. McConnell, Management Control Systems (John Wiley & Sons), p.7.

cannot.[13] The impact of machine on man in this sense does have an emotional aspect on management but in most respects it is one of relatively short duration. The first mild shock experienced as a result of computer processing can be followed on one hand by a complete blind acceptance in which man merely becomes the tool of the machine or, on the other hand, it can be followed by a feeling on the part of management toward the processing system of either resentment or a sub-conscious feeling of rejection. The reaction in either case is, of course, wrong.

Management must accept data processing as the helpful tool that it is, but accept it with an inquiring and open mind. They should not become its slave by blindly accepting the product which it emits. It must be constantly borne in mind that this product is merely one link in the Company communication system.

A punched key card or a long tabulated report which is the mechanical result of a data processing system is a vital segment of the communication system but, at the same time, it is a thoroughly impersonal item. This is evidence of another part of the ADP environment, the inherent impersonality of it all. As we shall discuss in more detail later, an ADP installation has the capability of extending the reach or span of management's control enormously.

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[13]Joseph W. Newman, "Behaviorial Scientist," Harvard Business Review, July-August, 1958.

Associated with this extended reach is an almost exactly reciprocal loss in the personal touch between management and all other levels of the organization. If one has ever looked at his personal history or record of job qualifications as punched out on sheet which is a product of a business machine, he must have been immediately moved by the thought that this card or paper only tells part of the story. For example, if in describing a job previously held, the report does not in the mind of the individual do justice to the real concept of the job by merely giving it a name. The report does not begin to tell how tough the boss was, or how long the hours were, or that one was promoted over many more experienced people, just to name some personal reactions which might pass through an individual's mind. It is this lack of personal touch fostered by the business machine which management must assidiously seek to avoid. Management cannot afford to shut themselves up in the proverbial "Ivory Tower" and let life go on its way about them. The finest new data processing system will not replace the need for personal communications between all levels of management because "the people most qualified to speak on what they have done, are doing, can do and might do, are the people themselves."[14]

But just as management must not isolate itself it

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[14] Evaluation Report Phase I PERT.

also must not become so embued with the staff concept that it fails to serve the line organization. This latter concept is today the result of yesterday's experience which to an overpowering extent shapes the attitudes and concepts of the executive. The tendency is invariably to enhance the staff position with the attitude that the executive can himself do the job better than turning it over to someone else. Although there may have been room for concepts such of these in the past, their value in the control environment of ADP is extremely doubtful. Time has been compressed as has the capacity to handle the minutia of detail by today's computer installations. Solution time is now measured in micro-seconds or even less. As a result, it has been stated with a good basis for fact that "we now have in electronics computers the literal ability not to swamp, but to bury a manager."[15]

It is vital that management and managers become the standard bearers of a new era represented by the age of automation. Top management must pursue an openminded and energetic course if they are to succeed with ADP. Flexibility of organization, reliability of communications, willingness of acceptance, inquiring intelligence and the keen awareness of the importance of the "human" contact are but a few of the many things that will be and are required

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[15]Owen Smith, address to National Association of Accountants, reprinted in The Controller, October, 1961.

of management in the ADP environment.

The Organization and ADP

"Organization has been made by man, it can be changed by man." - Wm. H. Whyte.

Since organization is of man's creation and is composed of men, it takes on the personality of man and can, therefore, be expected to at least some degree reflect the behavior patterns of the physical collectivation of men. It will also reflect to an even greater extent the personality of those key personnel who are at its head. Add to this the influence of automation (in our case, ADP) which has an effect which is quite apparent on man and there will be a corresponding effect on the organization and its character. It is this effect of machine on the organization which we seek to examine briefly.

An automatic data processing system makes many demands on an organization. Not the least of these demands are those placed on the communications system. As stated earlier, ADP has compressed time and in the process has become a system of almost unlimited productivity provided that the necessary input materiels can be gathered and put into the process. It a never ending round-robin process in which the greater the output the greater the demands on input and the greater the input the greater the demands on the communication system and the individuals which must collect the required data. As management sees the ability

of the process to produce data with which to make more timely decisions, more demands are placed on the process and in turn on all the descending levels of the organization. The end result of all this is a very strong pull on the part of management toward centralization of the organization.

The tendency toward centralization is further heightened by the very fact that decisions can be made better and faster at the top of the organization where the fountainhead of ADP is available and this, of course, is the result of the capability of the computer process to consume myriads of details, digest them and emit data for decision making which has considered all parts of the organization from sales to production. This is impossible at virtually any other level than at the very top of the organization. Management very naturally as a result of all this will seek to bring control back to the central point.

But the concept of decentralization has of late been the pet theme of modern management.[16] The pull is there, centralization at one end of the organization and decentralization at the other. The stress and strain is even further complicated by virtue of the fact that even if the data are available, even if the data is collated in this fore-shortened period of time and even if a timely decision

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[16]Edward C. Schleh, "The Essence of Decentralization," Advanced Management, September 1959, p. 8.

results, can management execute timely action in keeping with all that has gone on before? Without centralization, the ability to take timely action is at best a doubtful factor. But carry the situation to an extreme. Imagine, if you will, the organization which would be matched with the ultimate in data systems, that is the system which is so fully automated that the computer not only collects the data but makes the decisions and sends them on to the implementing section of the automated process. There could hardly be any "levels" in this sort of a chain of command, in fact, we might say that this is the ultimate in complete centralization.

Still another area in the picture of the return to centralized management may be considered. This has to do with the physical placement of the computer system within the organization. Ideally, there are many other uses in an organization for an ADP system other than at the level of top management. There are applications for the data process system throughout the entire length and breadth of the organization. For example, in a manufacturing process there are many uses for such a system in quality control operations. The sales and shipping divisions can logically have many extremely important uses for a computer system. What happens to the centralized organization under situations such as these? The answer, of course, lies in the fact that the organization must not allow itself to be centralized to the extent where the maximum profitable use of the ADP system

cannot be realized. There is and it must be found, that point of ADP organizational level within the organization which is the optimum. The important consideration is that the placement of the data processing function should be made in the organization where it can best serve all functions of the business and in turn the business itself must be founded on an organizational structure which permit a realistic relation between the organization and the objectives of the data processing function.

Finally, the dynamics of decision-making under an up-to-date computer system must be realized. Heretofore executives have been forced to base their decision on reports that were primarily historical in nature and, in effect, a static situation was created for examination and any projections into the future that could be made were made either on the basis of almost pure conjecture or on the basis of elaborate estimates. In addition to this, the static situations which were constructed were for the most part concerned with only a selected segment of the business. With the capability of modern systems it is now possible to create dynamic situations which will permit the examination on a "living" basis and which also permits, more importantly, the study of cause and effect simultaneously throughout the entire business or industrial process. Management is now able to interrelate the flows of information, materiels, manpower and money in order to achieve the optimum efficiency

of operation.[17] With the overview of company operations thus made available to top management it will become possible for the policy level of an organization to spend more and more time establishing policy while day to day decisions will be made at more subordinate levels. The implications of this new capability on management and their organization cannot be overemphasized.

Although ADP will not in the foreseeable future place management in "the role of a locomotive engineer watching guages and dials; and then, pulling control levers,"[18] it has and will continue to open up new vistas of operations and organization. Unfortunately, associated with these new horizons are many problems which will only be solved by a management whose outlook is alert, inquiring and progressive. The preceding brief excursion into the ADP environment, has been just that--brief. The surface has only just been scratched but the purpose of the paper has been served if the reader has gained some small idea of the problems which are thought to be associated with this new environment and some of the current thought concerning their solution. There can be little doubt that we are embarking on an era which portends to bring with it a trend toward "recentralization"

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[17] Jay W. Forrester, "Industrial Dynamics--A Major Break-through for Decision Makers," Harvard Business Review, July-August, 1958.

[18] Wallace A. Bounds, "How Technical Future Management?" Advanced Management, October, 1959.

of management functions and toward an organizational philosophy which if not new will make the utmost in demands on top management if they are to make the most of the opportunity that the automatic data processing system will set before them.

CHAPTER III

CRITERIA FOR SELECTION OF AUTOMATIC DATA PROCESSING EQUIPMENT

Chapters I and II have presented information concerning the ADPS, i.e., history types, system fundamentals, human elements, etc. In this part, the criteria for selection will be presented. Various methods which could be used in determining feasibility of installation will be discussed with emphasis placed upon the guidance committee method using the feasibility study and related application study.

Phases of Development

Users of ADPS have been through several phases of emotion since the introduction of this process in business. These phases can be divided into three eras, which are:

1. The phase of expectation. In the World War II era, Winston Churchill was reputed to have said: "Too little -- too late." In the first phase of computer usage, many corporations could have used the contrary expression -- "Too much, too soon." The impact of the ADPS has been felt throughout the industry, military, economic, business and other sectors. The initial glamour associated with the benefits to be derived from the use of ADPS in these sectors

has been somewhat dulled. More often than not, the "too much, too soon" phase could have been forgotten and replaced with -- "Why haven't we prepared for this sooner?"

One of the most apparent characteristics of the failures associated with the use of ADPS is the lack of objectives from the inception. This can be expressed by the conversation between Alice and the Cheshire cat.[1]

"Cheshire puss," she began timidly, - "would you tell me which way I ought to go from here?"

"That depends a good deal on where you want to get to," said the cat.

"I don't care where--," said Alice.

"Then it doesn't matter which way you go," said the cat.

E. D. Dwyer, Chief, Navy Management Office, points it out another way. "ADPS failures are the results of management proceeding from unwarranted assumptions, to foregone conclusions, unimpeded by facts."[2]

2. The Agonizing Reappraisal. Oftimes, a corporation finds to its dismay, that due to a myriad of reasons, the ADPS installation has not proven wholly adequate. Few organizations have been able to capitalize on the full capability of an ADPS, due mainly to management's lack of education/ familiarity with the system. All good things

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[1]Lewis Carroll, Alice in Wonderland.

[2]E. D. Dwyer, Chief, Navy Management Office, "Management Re-education." Address before the American University's Fourth Institute on Electronics in Management, November, 1957.

take time, likewise it will take time for management to realize the full potential of an ADPS -- in the interim, the promises of the advocates of ADP are sufficiently exciting to stimulate the most conservative.

3. The third phase is the present phase (there may be more). This phase may be called "The first signs of success," and is characterized by the effects of the successes of ADP. These successes have taken many forms. Since computers have cut across departmental lines, they have wrought many changes in business management, especially in its use as an office tool. With its ability to digest copious quantities of information, the computer has stepped up the emergence of the corporate control official, be he the Financial Manager by name, or in fact, The Controller. The controller's office is the information-intelligence center of the business, and as a result, the controller/financial manager is the one executive who may know more about the business than the President.

As was pointed out in the Senate hearings on office automation and Employee Job Security,[3] held on March 2 and 4, 1960, the one big advantage of the ADPS is the centralization/integration of work areas into single systems, e.g., payrolls. It has been pointed out in Chapter III, organizational changes must take place to use ADP effectively.

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[3] U. S. Government Printing Office document No. 52499 of March 2, 1960.

Techniques of Selection

How does an activity plan the introduction of an ADPS into the organization and who is the responsible official?

Responsibility for determination of criteria rests with the senior policy official of the organization. In the case of the Department of Defense, (DOD) this is an official within the military establishment designated by the Secretary. For some project installations the Assistant Secretary of Defense (Comptroller) will be responsible.[4] In the private business sector, it has been suggested that the financial manager recommend and that the President approve the criteria for selection.

There are several methods of determining the selection criteria. No one approach has proven highly successful. Each activity has different problems, background, requirements, organizations, personnel, psychology of business, etc. Oftimes, the installation of ADPS comes about as a result of several methods of criteria selection. Some of these methods are:

1. "Keeping up with the Joneses"
2. "The One Man theme"
3. "The Outside Consultant"

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[4] DOD Directive, 5105.14 of May 6, 1958.

4. "Guidance Committee Approach and feasibility study".

1. "Keeping up with the Joneses"

Not many organizations will admit that an ADPS was installed to "keep up with the Joneses". All too frequently, however, this appears to be the underlying reason for the installation and the unhappy results were all too numerous. As can be expected, such installations are accompanied by much noise, exaggerated claims and inadequate preparation and planning. (including management orientation).

2. "The one man theme"

"The one man theme" is succinctly pointed out by Elmer Kubie, computer consultant and President of Computer Usage Co., New York, who says, "It is my observation that almost all applications of computers can be traced to an impatient man somewhere in the organization. Moreover, this man's desire for a computer is seldom strictly logical." The overly enthusiastic advocate of ADP can be a dangerous person. He may be in a position to influence top management into installing an expensive ADPS without adequate planning or preparation. This approach to machine installation is sometimes successful but more often than not, it is costly.

The area of cost-savings is often used by the enthusiast in his selling approach. It is in this area where the greatest over-selling job has been done. In all fairness to the computer people, it is appropriate to state that

limited research has indicated that they have attempted to play down the cost-saving factor.

3. "The outside consultant"

The use of the outside consultant is very often a feasible method of determining criteria for selection. There are several advantages and conversely, there are several important disadvantages to the utilization of this method by any activity. Some advantages are:

a. Cost of the outside consultant can be charged to operating expense, or to the feasibility study, provided one is conducted.

b. The outside consultant is not hampered by company prejudices.

c. Decisions independent of company pressures are more objective.

Some disadvantages are:

a. Cost may be prohibitive.

b. Experience gained during the study is lost to the outside consultant--internal study has advantage of training company personnel.

c. The outside consultant often does not have all the intangible information required to establish selection, e.g., personality of the top management.

4. "The guidance committee approach"

The guidance committee approach is the one usually recommended to assist top management in arriving at

a decision to use ADPS.[5] This committee should be composed of middle management and should be implemented by a working committee or "task group" composed of representatives for each area affected by the proposed installation. The task group must be free to work full time on the project and must be guided by the guidance committee. The first project of the task group is to familiarize themselves with ADPS. This familiarization phase can be accomplished by each member attending manufacturer's schools, visiting ADPS installations, reading the volumes of literature available on ADPS and for those in the military--attending the various courses of study given by the military establishments, e.g., U. S. Navy Postgraduate School, Monterey, California offers several courses of study involving ADP theory and application.

The guidance committee must outline areas of interest in order of priority in which the task group will make a thorough study. Due to the complexity and magnitude of the study, individual members should be assigned an area of responsibility, e.g., one member will study location, one will study costs, another the human factors involved, etc. This phase generally takes anywhere from four months to one year. The costs of the time spent in committee can be charged to the installation costs or to administration expense if the decision is not to buy. One may inquire, "What method of

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[5]Edley Wainwright Martin, Jr., Electronic Data Processing, An Introduction (New York: Richard D. Irwin, Inc., 1961), Chapter 15.

approach should the task group use in studying the problem?" This approach could very well be termed the feasibility study approach and will be explained in detail.

Four methods have been mentioned to assist management in determining selection criteria. In short, the needs of the organization versus the costs of the installation plus intangible factors will determine to a great extent what method of selection will be used.

In some large organizations, there may be basic selection criteria set forth, e.g., in the Department of Defense there are two prime factors to be considered in the selection of ADP. These two factors are:

1. Its capability to fulfill the system specifications including any time constraints and,
2. Its overall costs in terms of acquisition, preparation for use, and operation. It is interesting to note that the term "overall" costs shall include such costs as personnel, purchase or rentals, maintenance of purchased equipment, site preparation and installation, programming and training.[6]

Most activities contemplating the installation of ADPS must start from a complete lack of information regarding ADP. The first few months are generally ver confusing and

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[6]DOD Directive 4105.55 dtd August 15, 1961. Subject--Policy on Selection of Computers.

it is during this stage that consideration is given to contracting the job of determining selection criteria to the outside consultant. In order that the organization grow with the system the outside consultant method, as previously mentioned, should not be used unless absolutely necessary. Management may be unable to decide how the new system will affect the business or for that matter what course of action to take in order to proceed efficiently. One of the most important steps in determining selection criteria is to obtain the support of top management. Once top management support is obtained, it then becomes necessary to assure the "working people" that ADP will not deprive them of their bread and butter. (Personnel considerations are covered in chapter III). The point must be made, however that top management wants and expects effective results from the task group and in this regard, the task group would be assisted immeasurably by the support of the unions affected by the installation.

Feasibility Study

Prior to the commencement of the feasibility study, the guidance committee should establish the basic guidelines and objectives of the study. Personnel are selected for the task group and each member of the task group should become familiar with at least one facet of the planned operation. At this stage of organization, one cannot expect the task group members to be experts. The longer the time allowed in

the initial stages of the study, the better the results usually are. If the results of the study indicate that ADP is not the answer to management's dilemma, only the costs of the study are lost. Results of recent studies conducted by the U. S. Navy indicate that nine months lead time is not too soon to commence training personnel for the feasibility study.[7]

A preliminary feasibility study should determine data-information requirements, available equipment, personnel requirements, costs to complete a detailed feasibility study and estimated costs and benefits to be derived from the proposed systems. It must be recognized that although monetary savings are important, the guidance committee should not be too optimistic. It is better to underestimate dollar savings than overestimate for there are many skeptics who will not hesitate to say "I told you so" if the results of operations do not prove the study.

Once the decision is made to commence the full feasibility study, the guidance committee must state the objectives. As previously mentioned, broad objectives may have been set forth prior to this time. With the objectives stated, the task group then commences a detailed survey of data processing functions. Source documents, basic reports, and even informal raw data, e.g., movements of personnel in

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[7] Cdr. M. Vance Fowler, USN, "So You Think You Want a Data Processing Machine." Monthly Newsletter of the U. S. Naval Supply Corps, May 1959.

taking inventory should be studied. This flow of data is traced through the entire operation and identification of man-hours, effort and other significant cost elements are noted.

Upon completion of source data collection, it usually becomes evident that relatively few areas comprise the majority or significant portion of the entire operation. These so-called "primary applications" become the basis for detailed analysis. Such analysis are undertaken to determine where the particular operation fits in the whole chain and helps determine the best way to accomplish the job. This preliminary analysis usually becomes the basis for the application analysis that is undertaken upon completion of the feasibility study.

Applicability Study

Prior to the selection of ADPS and subsequent to the feasibility study, an application analysis should be conducted. This analysis may be conducted by two methods:[8]

1. One method is concerned with the detailed analysis of existing procedures and data to obtain a concise definition of the problem.
2. The other method tends to ignore the existing procedures and to state in a real sense the output

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[8]See also Robert H. Gregory and Richard L. Van Horn, Automatic Data Processings Systems (Wadsworth Publishing Co. Inc., 1960), Chapter 11 "Systems Analysis and Design" and Chapter 16, "Applications Study and Equipment Selection."

requirements which must be generated from basic source data.

The first method is one that has been in use for many years. It is familiar to most all management personnel and its use has resulted in much simplification and cost reduction in business although not always in the most efficient manner. In conducting an application study/analysis using this method, one must not overlook the time involved in data collection and analysis of this data. In addition to the time element involved, personnel conducting this study very often have difficulty in adequately defining or describing the application of the data collected.

The use of the second method appears to have greater potential. Procedures for use of an ADPS cannot be planned effectively until the end product is determined. One way to conduct this method is to analyze the documents presently being produced (only to avoid omitting needed data). The uses of these documents and the actions of the people receiving them is pertinent. The ideal output document is one which contains all information logically necessary for each person to take proper action. If the application study should recommend that ADP not be adopted, an additional benefit and activity report analysis and application would be reaped. Once the ideal output product is determined, it then becomes necessary to relate this ideal output with available input since all output must be logically or mathematically derived

from some preceding input or reference. With input and output data determined, it now is necessary to relate this to machine capabilities. At this stage, one must assume that ADPS can bridge any gap between available input and desired output.

Additional requirements may be stipulated by the prospective purchaser, e.g., "Will the ADPS be compatible with COBOL? or "The output product must be designed to insure full and free competition among qualified equipment manufacturers."[9]

In actual practice both of the above approaches have been used and usually some sort of compromise plan of action is taken. In any case, regardless of method or compromise used, certain basic principles should be observed. Some of these principles are:

1. Analysis of sources and data available at sources is always essential.
2. Output should be idealized, but one must realize that virtually, (as yet), no ADPS will completely satisfy all the requirements which could be stipulated.
3. Reference information should be developed as a logical sequence to the matching of basic input to idealized output.

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[9]DOD Directive 4105.55 of August 15, 1961. Subject--Policy on Selection of Computers.

4. Automatic analysis of data and actions, if properly matched to purchaser's requirements can be a simple task even though it is burdensome in terms of volume and data collection time.

Upon completion of the feasibility study and related applications study, the systems analysts should be consulted in order to select the best equipment available that will meet selection criteria which had been formulated. This systems analyst in many cases will be an outside specialist selected for his technical knowledge of accounting, electronics, economics, production, systems design, etc. He should be given a "free rein" to consider unusual opportunities and completely different ways of doing the job desired however, the task group must be kept fully informed and work in close harmony with the system analyst in order that the analyst keep from devising schemes that look attractive on paper but would fail if put into operation, also, duplication of effort would be avoided. Care must be taken at this point to avoid the pitfalls created by the over-zealous analyst. Many times, especially in smaller organizations, less costly systems such as EAM can be employed to better advantage.

Mr. W. F. Spengler, Comptroller of the Owens Illinois Glass Company said at an address to the Navy Graduate Financial Management Class on December 12, 1961, that their Company considered the most important selection criteria to be dollar savings when considering the installation of ADP equipment. On the other hand, Government purchases of ADPS

are based on several criteria,[10] among which are intangibles such as decreased process time, increased accuracy, greater dependability, ADP equipment do not require coffee breaks, and better predictability of results. Such intangibles oft-times offset arguments against the installation of ADP based solely on dollar savings.

All costs associated with the proposed installation should be included in the feasibility study. Such items as air-conditioning, new construction of office space, office rearrangement, personnel training or retraining of displaced persons etc. are often hidden costs and can very often become significantly unbearable, thereby causing top management to reconsider the entire proposal.

In summary then, an application study is an extension of the feasibility study. With the preliminary work completed and assuming the decision is made to use an ADPS, the application study aims at the detailed analysis of the basic applications and the design of the optimum system. The detailed analysis may include such items as:

1. Flow of work details
2. Workload volume
3. Time standards and requirements
4. Document preparation

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[10] Bureau of the Budget Bulletin No. 60-6. Dated March 18, 1960. Subject--Automatic Data Processing (ADP) Program of the Executive Branch: Studies preceding the acquisition of ADP equipment.

5. Methods description to include elements of mechanization (especially true in systems with punched cards)
6. Cost analysis

Rent vs. Buy

Cost analysis requires some expansion. It has already been pointed out that the cost savings is often stressed by the ADP enthusiast as the primary reason to install the system. Another aspect of the dollar consideration is whether to rent or buy the ADPS. Some companies have a stated policy to rent for a given reason, e.g., Owens Illinois has the policy to rent because of the high rate of obsolescence of ADP equipment. The decision to rent or buy is one of major concern. The following factors should be considered:

1. Advantages of renting
   a. The efficient life of the equipment cannot be predicted with accuracy due to rapid technological advancements in this field.
   b. Renting is a hedge against developments of ancillary equipment that may not be compatible with present equipment.
   c. Spare parts do not have to be carried in inventory at the expense of the user.
   d. Rental agreements can usually be made with option to buy.

e. Rental agreements may be advantageous for a fluctuating market condition. Sale prices of ADP equipment have been recently established and prices are not "firm".

f. Certain tax advantages accrue to rentors of ADP equipment.

2. Advantages of buying

a. ADPS have been operating dependably for about six years and more.

b. Older ADP equipment may be moved to a lesser demanding program if it ceases to be economically efficient due to improved equipment available. This will enable the user to utilize the residual life of the older equipment.

c. A trade-in allowance can usually be arranged for purchase of new equipment.

d. If the ADPS is used more than one full shift, it is generally more advantageous to buy.

e. Purchase of equipment places a greater responsibility on management to utilize the equipment to its maximum advantage.

f. Maintenance problems can be handled by user personnel, thereby building up an internal maintenance organization.

When the task group completes the application study for determining the various criteria for selection, it then

becomes necessary to determine criteria for use. This criteria will be covered in the following chapter.

CHAPTER IV

CRITERIA FOR USE OF AUTOMATIC DATA PROCESSING EQUIPMENT

The use of ADP involves considerations relating to personnel, operating and administrative expense, and the specifics of management requirements. An overriding basic thought to be borne in mind by all users of ADP is the purpose of the installation. This will vary widely but as Arthur M. Cannon observed at the September 1960 meeting of the American Institute of Certified Public Accountants, "The significance of any statistical data rests on comparison with some standard and not on the absolute data."[1] Moris Budin amplifies this by saying, "Reporting systems that just record histories of accomplishments and indicate problems are only doing part of the job they could do."[2]

The astounding speed and flexibility with which ADP can process a problem often results in management losing sight of why the installation was made. Furthermore

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[1] "What's Wrong with Financial Reporting," The Journal of Accountancy, August 1961. A symposium.

[2] Moris Budin, "Reports: A Problem in the Control Function of Management," Advanced Management, June 1958.

the sophistication of the mathematical techniques used in Operations Research, System Analysis, and the eventual programming of the ADP equipment cause some managers to overlook the limitations. The most significant limitation is personnel. In Chapter II we discussed the effect of the computer installation on the human element, the management, and the organization. These impacts cannot be overstressed. In the actual use of ADP additional factors rise which must be understood, evaluated, and applied to corporate advantage. These include source of personnel, training and retraining of employees and the continuing aspects of employee and public relations.

The key employee selected is the manager of the data processing installation. Equipment manufacturers have made studies of the requirements for such an employee. A representative comment from the International Business Machine Corporation is:[3]

> One of the most important considerations when installing data processing equipment is the selection and training of personnel. . . . there is no set of rules which can automatically guarantee that the requirements for personnel of the desired type will be met.
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> The most important person to be selected is the data processing manager. This should be done with considerable care as this individual will be responsible for the direction and leadership of all phases of the installation program. . . . Candidates to be considered should have the following general characteristics:

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[3]International Business Machines, General Information Manual, "RAMAC 305 Instruction Manual," p. 10.

1. Be alert and inquisitive individuals.
2. Possess ability to get along with people.
3. Have ability to apply logic to the statement of a problem and its possible solutions.
4. Possess aptitude and desire for systems work.
5. Some knowledge of data processing equipment and its use is desirable though not essential.

In addition

The top candidates should be considered further as follows:
1. Be presently in a supervisory capacity and possess comprehensive knowledge of the equipment to be installed.
2. Have past experience in methods work and knowledge of the operation of data processing equipment if possible.
3. Be capable of management presentations.
4. Have demonstrated ability in the foregoing.

Criteria such as these can be simply described as overwhelming. The probability of an organization filling the position of data processing manager from within the organization and at the same time meeting these standards is unlikely at best. In practice this has resulted in recruiting personnel from outside with the obvious consequence that an important middle executive is employed without adequate knowledge of the history, policy and procedures of the company. Understanding this limitation but recognizing the size of the investment in the average ADP installation the likely solution is to train the new employee in the company's background. This cannot be overlooked if the use of the ADP is to prove successful since only by such action can the basic purposes be exploited to the full capability of the machine.

Having selected a data processing manager the same

source indicates the nature of responsibilities which should be assigned to him:[4]

1. Provide the communication link between management and the programming group.
2. Originate and maintain the progress and planning schedule.
3. Assist in the selection of people necessary to augment the effort in application studies and programming.
4. Establish a training program covering the required levels of technical proficiency.
5. Assist in the selection of a site for the physical installation of the equipment.
6. Conduct and control the application study and make formal recommendations to management.
7. Assist in formal and informal public relations procedures.
8. Determine and plan the necessary cutover procedures for the "system".
9. Prepare operating procedures in accordance with sound accounting practice.
10. Accumulate and establish necessary data to establish a budget on a realistic basis.
11. Supervise the program list at an IBM data processing center.
12. Evaluate the performance of the system after installation and make recommendations to management for future activity.
13. Other activities may include training programs for affected personnel or those who will provide new type of data for the system; assistance to personnel in securing reassignment, or promotional or advertising effort in accordance with management desires.

It must be emphasized that these criteria and suggested duties represent the point of view of one equipment manufacturer. They, nevertheless, are typical of the wide ranging personnel considerations applicable to the data Processing Manager. Those positions of the suggested duties which relate to preinstallation studies site choice, etc. will require modification in the particular case depending

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[4] Ibid., p. 11.

upon the method of equipment selection which is used. These methods have been previously discussed in Chapter III.

With a data processing manager selected important choices remain to fill the balance of positions. A minimum of disruption will occur if substantially all of the clerical and operating type personnel requirements are satisfied from within existing employee rolls. The great advantage of this technique is the stability of employment offered and this advantage should be stressed as policy in the public relations and employee relation efforts incident to installation. The required training courses are available in most instances from the equipment vendor.

It is also to be expected that the normal attention in clerical personnel will provide the openings required to accomplish any personnel reduction expected from automation. This expectation may not be completely realized. Actual case histories of automation were studied recently by the Joint Economic Committee, Congress of the United States by the Subcommittee on Automation and Energy Resources. These case histories were summarized:[5]

1. Out of a total of 3,906 jobs affected by automated innovations layoffs and discharges were negligible.
2. Installation time allowed plenty of time to plan and prepare reassignments for personnel affected by new equipment.

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[5]"New Views on Automation." Papers submitted to the Subcommittee on Automation and Energy Resources, Joint Economic Committee Congress (United States Government Printing Office, 1960), p. 209.

3. Management and labor in cases where union representation prevailed cooperated to minimize the impact of dislocation. In addition retraining was provided by the employer.
4. Downgrading was kept to a minimum and pay rates were kept at the old scale in most instances. In a substantial number of cases employees were upgraded with resulting pay increases.
5. Wage rates were increased during the period.
6. Management was satisfied with the increased efficiency and the employees adjusted to the technological skills associated with their new job ratings.

The tendency of ADP installations to grow in something similar to the application of "Parkinson's Law" is often viewed with dismay. Actually this situation is a symptom of either progress according to a realistically conceived plan or more often indication that management has lost control of the equipment and work is being generated because the machine has the capability but without regard to the profit (loss) contribution of the requirements. This latter situation is intolerable and represents incompetent action. To be critical of the equipment in such a situation is illogical. It cannot be too emphatically stated that the use of ADP requires basic understanding of capability versus total management requirements. These must be expressed in a plan which leads to at least the machine utilization and pay-out which was assumed in the feasibility study.

Personnel Considerations

The personnel considerations which have been discussed can be restated now as these criteria:

1. Hire a manager who can supervise, who knows the equipment capability, and who can be taught the corporate practices.
2. Retrain as many existing clerical employees as possible to the new equipment. Use manufacturers training facilities to the fullest.
3. Continue training in new techniques for employees using ADP. This is most essential for programming personnel.
4. Provide job opportunity and new job training for the few displaced employees.
5. Stress the advantages of the ADP equipment to the company and the employees in all of the public and employee relation media.

Personnel criteria in the use of ADP equipment are important but since profit to the company is a basic consideration it remains to consider aspects of operating and administrative expense encountered in the application of ADP. Basic considerations such as outright purchase versus lease arrangements have been discussed in Chapter III. During the life of the installation these basic considerations should be periodically reassessed to insure that the corporate concept of operating the ADP equipment remains valid. This periodic review is most appropriate whenever additional functions are to be added or additional equipment procured.

The actual day to day operation requires consideration

of the costs of shift operation versus premium pay for operators with attendant increased overhead costs, the possibility of rental income by leasing out equipment time to other companies, the cost of increasing the scope of automated operations which could be accommodated without an increase in equipment, the costs of paper and supplies for the installation, and the costs relating to the location of the machine room in relation to other centers of activity.

The large size expensive automatic data processing equipments must be operated on as near to a continuous basis as possible for two reasons. First, because increased operating time reduces the unit cost of operation and is thus the most economically efficient and secondly, to provide the earliest possible results from the input data. Multi-shift operation introduces premium labor costs by virtue of overtime and shift premiums as compared to straight, regular hour operation. The added costs are trivial compared to the advantage gained. This is true even when the additional costs of power, light and necessary employee service expense are considered. It is essential that shift operation of ADP equipment include qualified supervision. Without such insurance the cost of error can be prohibitive. This is particularly true when the oncoming or day employees in other operating and administrative units of the company are depending upon availability of a data run to perform their tasks.

Having selected the optimum times to run the ADP

equipment for internal purposes the company should make specific allowance in the equipment schedule for down time for maintenance. Regularly planned progressive maintenance requirements are outlined by all equipment manufacturers and in most cases will be provided by them. The advantage of this method is dramatically evident when unscheduled down time is avoided. In this sense the ADP equipment is no different than any other expensive and critical capital equipment.

Normal operations plus scheduled maintenance may not utilize the total time available. In this situation the possibility of leasing-out computer time to other concerns should be explored. When this technique is considered the time made available to other users should be compatible with the owning concern's report schedule. It may not be practical to rent time to others and deny your own company the advantage of prompt reporting. If this objection can be overcome idle equipment time and machine capacity can be used to reduce expenses.

A large growth in operating expense is not unlikely in ADP installations. This point has been previously noted but is such a common occurrence that it is repeated here. Richard Sanzo emphasized this aspect in a recent article.[6] "The new equipment must be considered in relation to the entire program of mechanization and can be successful only

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[6]Richard Sanzo, "How Data Processing Affects Credit Department Operation," The Controller, August 1961, p. 396.

if the overall program is successful."

Faulty analysis is the usual reason for increasing scope of ADP operations in an unwarrantedly expensive way. Each added automated process must be capable of demonstrating a pay out in reduced cost and each piece of added equipment must be considered in the total plan for automation. The analysis of pay out in these applications must be extended to cover all savings. As International Business Machine Corporation notes:[7]

> Contrary to what might be expected the largest dollar economies come from reduced inventories, lower sales and distribution costs, smoother production scheduling and the other benefits of closer management control over operations. . . . Although there should always be room for expansion of the objectives whenever new benefits can be realized, the immediate goals to be sought should be fairly well crystallized at the time management approves an overall plan.

In general the scope of operations of ADP installations increase by adding equipment. This is not always the case. Frequently unnecessary and overcomplicated reports are generated merely because the equipment presently existing has currently unused capacity. This will be discussed later under the section relating to management utilization but it is essential to recognize here that elimination of unneeded reports and simplification of required reports can significantly reduce operating costs. A derived benefit is the availability of machine capacity for essential purposes of

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[7] International Business Machines, General Information Manual, loc. cit.

the company.

Another aspect of operating and administrative expense is the optimum location of the data processing installation compared to the points receiving services from the installation. This facet should receive careful consideration during the studies made prior to acquisition but more often than not changing circumstances, techniques, and policies invalidate the original location studies. Nevertheless basic factors such as space, power supply, floor loading, instrumentation, proximity to engineering services which are included in original technical studies must be supplemented by logical location for ease of operation. This may be aggravated when not considered initially by the rising costs of data transmission by telephone, teletype, or other sophisticated means. In an interesting recent comment, Mr. W. F. Spangler, Comptroller of Owens-Illinois Glass Company said:

> Speed of communications between activities is now the greatest stumbling block. . . . Station wagons with drivers between plants is sometimes the most economical method. . . . Teletype is not entirely adequate.[8]

Not only are communication costs a problem area but management must also consider the timeliness of the automated data. If the great advantage of ADP is its speed and completeness it follows directly that the time of receipt

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[8] W. F. Spangler, Comptroller, Owens-Illinois Glass Company in an address to The Navy Graduate Comptrollership Program, George Washington University, 12 December 1961.

by the user is also important. The most logical solution to these problems is the optimum location of the data processing facility in relation to the units served.

Finally consideration of operating costs must consider day to day expense such as routine supplies. This is often dismissed as a minor, unimportant aspect but it is significant when viewed in terms of nonstandard forms and file costs. Using as nearly similar forms as possible leads to ease in presenting data, lower material costs, and facilitates storage. The storage expense itself should be minimized by virtue of using tape, cards, or memory units in the equipment rather than expensive filing of paper.

Administrative and Operating Expense Criteria

To summarize the aspects of administrative and operating expense in criteria for use consider:

1. Optimize period of operation by balancing necessary operating time versus time data is needed.
2. Rent-out unused capacity.
3. Make a pay out analysis before adding functions or equipment.
4. Consider location of equipment in detail to minimize communication cost and insure timely data.
5. Do not neglect routine administrative expense details.

The overall operation of the ADP installation should be periodically reviewed. An agenda for this review would include operating and administrative expense as a principal item for discussion.

In actual practice the management utilization of ADP equipment are the decisions which result from the data supplied. This was well expressed recently: "No matter how skillfully programmed, computers should merely provide management with more chances to make decisions based on better more timely information."[9] Management utilization criteria, then, can be developed by considering the nature of reports required, the use of statistical sampling versus complete tabulation methods, the optimum frequency of reports, provision for decision feedback, scheduling of reports, and forecasting techniques. It is intended here to highlight these aspects only briefly because the professional literature in this area is well documented. The applications of the literature to specific ADP installations is varied and requires detailed knowledge of local requirements.

The nature of reports is a function directly of the level of the report user. It is illogical to provide all of the information which ADP can generate to all of the executives who require some part of the information.

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[9]"Packaged Logic for Computers," Business Week, September 23, 1961.

The mere volume of detail will be enough to obscure the key facts and insure that the data will not be used. It is essential to confine reports to the facts needed by the executive to judge his own performance according to his responsibilities plus that data which is necessary to evaluate his immediate subordinate's performance. A report pyramid of this type is well adapted to ADP which can total out required summaries in one operation while yielding subtotals or line items in other operations.

This is not to imply that utilization should rely strictly on tabulation. Quite the contrary. As Russel V. Puzey recently stated:

> Late reports are most often caused by infinitely detailed accounting and the insistence upon absolute cut-offs and accruals. Detailed accounting, if carried to an extreme, does more harm than good as it comes too late and provides too many loopholes for excuses.[10]

Herein lies an important use of statistical sampling techniques as the basis for high level or operating management reports. These methods have been well proven in application to quality control and have substantially reduced inspection costs. The direct extension of such methods to report preparation on ADP equipment is logical and will provide cost reduction in reporting as well as improving timeliness. The method can be designed to produce whatever error probability is acceptable to

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[10]Russel V. Puzey, "Accounting is Communication," The Journal of Accountancy, September 1961.

management. It is well worthy of note that the resulting decisions also have an error probability even when completely accurate data is used as a basis.

The use of statistical sampling in the preparation of reports has ramification in the frequency with which reports are prepared. Reports should be prepared when they are needed by management, but consideration of administrative cost often results in a report which is too little too late. Statistical based reports which cost less than completely tabulated data can thus be available when needed. This is essential to gain full benefit from the ADP installation. The centralization of the report generating activity permits more frequent reporting. Here again the criteria remains the need for the report and not the ease with which it is prepared.

Reports must reflect the impact of management decisions. Policy changes are the type of decisions which have the greatest impact. This required feedback is accomplished most effectively by continued review of report procedure versus changing need, by footnoting or highlighting departures from expected performance with the reason when the reason is a prior management decision, or finally by regrouping data to maintain comparability with previous experience or future plan. In this connection it must be remembered that accounting reports only describe what has happened within the company and that they omit information about the future, that they do not include

non-financial data such as productivity and quality and that they do not include economic projections or political and emotional factors.[11] This is amplified in a recent article by D. Ronald Daniel, but the essence of the point is to insure that reports are used as an aid to decision and not in lieu of decision. They can be most valuable as an aid when proper decision feedback is accomplished.

Forecasting techniques are particularly well adapted to automated data systems. The large units with great memory capacity and programming flexibility can be used as adjuncts to the forecast responsibility of management. The computer in this case is only as good as the model which is constructed to use as the basis of the forecast. The range of possibilities with the attendant probabilities that can be explored is the advantage which derives from the ADP system versus the manual manipulations by a small group of specialists. The use of operations research methods in a corporate planning group is increasingly common in modern applications.

Factors in Management Utilization

The management utilization criteria for the Automatic Data Processing installation are these:

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[11] D. Ronald Daniel, "Management Information Crisis," Harvard Business Review, September-October, 1961.

1. Key reports to the need and executive level of the user.
2. Utilize statistical sampling methods to prepare reports vice complete tabulation of data.
3. Schedule reports to suit ADP capacity as a secondary consideration to need and cost.
4. Employ operations research techniques in forecasting as a supplement to judgment.
5. Insure reports are received on time.

Criteria applicable to personnel, administrative and operating expense, and management utilization have been presented. These are by no means all inclusive nor are they applicable in every situation. These criteria do indicate the type of thinking process which must be applied in the use of Automatic Data Processing equipment.

CHAPTER V

THE FUTURE

Computers of the future may have more impact upon mankind than the explosion of the first atomic bomb, or any other invention in man's long history. The computer, by its very speed and ability to solve in moments more and more complex problems provides the key to new knowledge. Collectively, computers will effect people in every walk of life; the laborer, the business man, the scientist, the engineer, the doctor, the lawyer, the politician, the military as well as the rulers of nations. In time, we may even see the religious leader turning to computers as an aid in the defense of their beliefs, and we may see international power plays being conducted by computers. In fact, our very survival may depend largely upon our competence in continually improving our computer know how.

Such prediction at first seem unrealistic and exaggerated, until one reviews where we are and where we will be going. But when one realizes that many large successful businesses are relying on computers for success, and we know that man's thrusts into space would be impossible without the aid of the computer we begin to appreciate the influence of computers. All of this has been achieved in a very short period of time, and yet man already has developed

electronic machines that will surpass today's giants. For example, we have a machine in use today that "can in five minutes solve the Thomas-Fermi-Dirac equation for the electronic density of nitrogen molecules which would require man 800 years to solve if he used pencil and paper".[1] And yet, new computers now being refined "will be twenty to one hundred times faster".[2]

At this time we might ask, why must we have computers with more and more speed? Certainly, today's computers are able to spit out more words faster than we can possibly read. As true as this may be this is not the real problem. Think back over the step by step method that a computer uses in solving even a simple program and one can visualize how fast each of these small steps must be solved if the final solution is to be timely. As the complexity of our problems get more lengthy, the individual steps that must be taken inside the computer also grow in length. In turn, these solutions inspire man to ask questions even more complex, questions man did not even know existed before computers presented the problem. To illustrate these steps involved in computer "thought" process the following example of a computer program for an automatic record changer is shown.[3]

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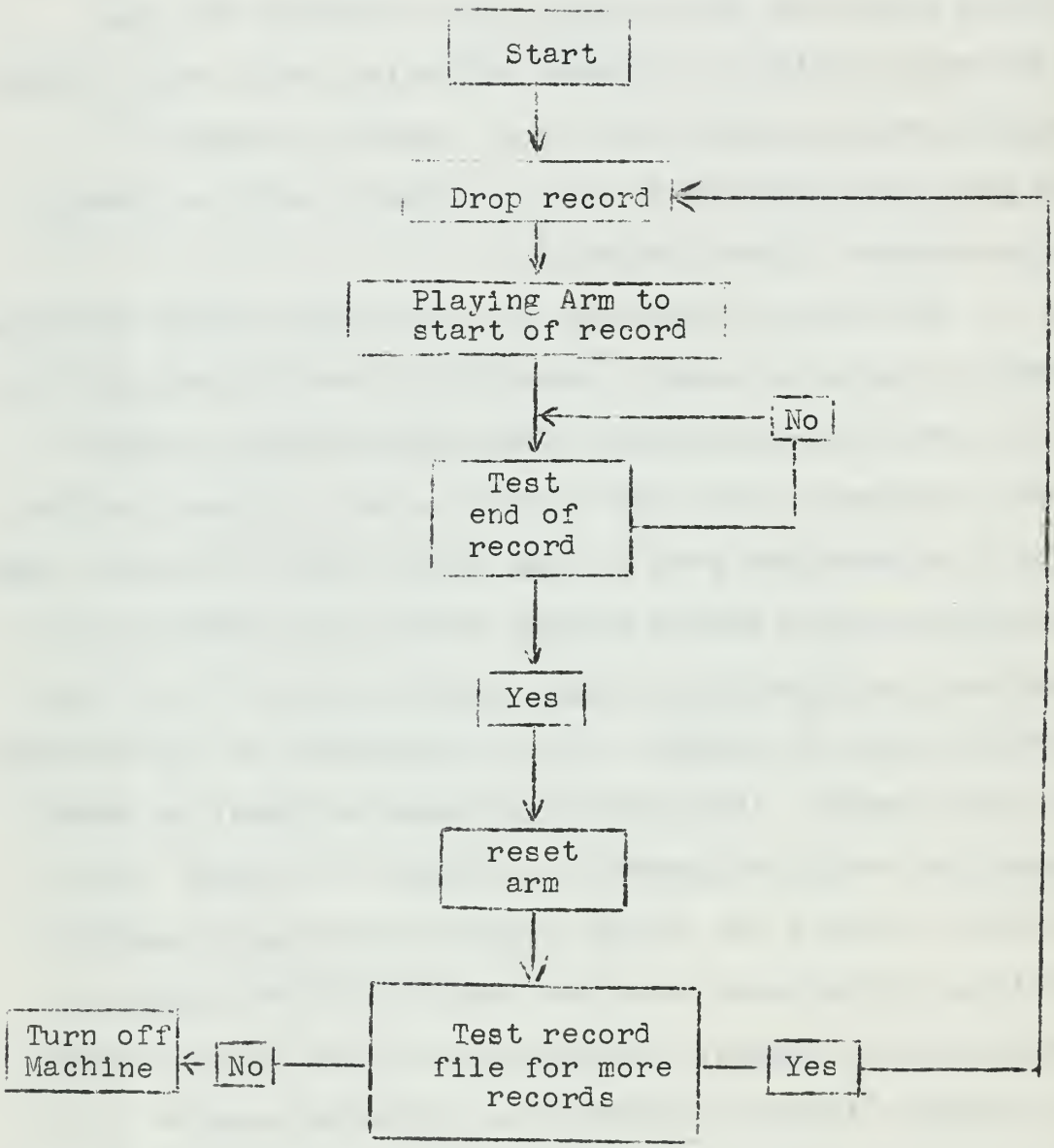
[1]IBM General Information Manual, Planning for an IBM Data Processing System (International Business Machines Corporation, 1959, rev. Aug. 1960), p. 21.

[2]George A. W. Boehm, "The Next Generation of Computers," Fortune, March, 1959, p. 132.

[3]IBM General Information Manual 1401 Data Processing System (International Business Machine Corporation, 1959, ed. rev. Sept. 1960), p. 6.



One of the major steps forward in increasing computer speed has been the marriage of individual computers into one big one.

> Heretofore, computers have been able to handle only one operation at a time. Some parts of the machine have been idle at a given time. Arithmetic units, for example, have had to pause for as long as several seconds while input units search for data in reels of magnetic tape. . . . The new

> computers waiting time will be cut to a minimum. The scheme of the National Bureau of Standards Pilot is typical. A primary computer will do most of the arithmetic calculations. A smaller secondary computer will act as traffic cop, keeping track of various parts of the program. Meanwhile, a third computer will control incoming and outgoing data.[4]

Another important step being taken to increase computer speed as well as simplification of programming and input data, is through use of precoded instructions for programming and creation of simplified input format. This means that in the future automatic programming will bypass the hundreds of steps now required, for the programming will be accomplished by placing only a few punched cards in the computer. These cards will be the result of a few simple meaningful English sentences being punched into cards. These few cards "in minutes rattles out the hundreds of cards bearing detailed instruction to itself."[5]

To further simplify the operation of computers, systems have been devised by which simple English language instructions are used to get answers to problems, instead of having to tell the machine where to locate the data and what to do with it step by step. For example, "typical instructions in computing payroll: MULTIPLY HRS-WORKED (B) BY RATE (A); SUBTRACT UNION DUES (A) AND BOND-DEDUCT (A) FROM ADJUST-PAY (A); STORE THE REMAINDER IN ADJUST-PAY (A).

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[4]Boehm, Fortune, March, 1959, p. 133.

[5]"Educating the Big Computers," Business Week, June 13, 1959.

The letters in parentheses refer to the magnetic-tape files where the data is to be stored."[6] In other words the long complex job of programming as well as questioning or instructing the machines has already been greatly simplified.

While it is comparatively easy to develop standard mathematic English to tell computers what to do, such as multiply and divide, it is another problem translating business expressions into a common computer language. However, as has been shown above, it is being done by each of the major computer manufacturers. The military on the other hand face even greater business problems, because they operate computers of many different sizes and of many different manufacturers. As a result through inner service conferences, the COBOL system was adopted by all of the services with its objective as establishing a "COmmon Business Oriented Language for programming computers."[7] The results of this effort will enable the free exchange of business information between installations, regardless of service ownership, manufacture or model of the equipment involved.

As we progress in both speed and ability to speak to computers in our own language others are hard at work

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[6]Boehm, Fortune, March, 1959, p. 143.

[7]Department of Defense, Special Task Group of the Conference on Data Systems Languages, "Report to Conference on Data Systems Language." (Washington, D. C.: Superintendent of Documents, U. S. Government Printing Office, 13 June, 1961), p. I-1.

trying to make computers think like the human brain. "Research on mechanized thought is inevitably converging with research on the human brain. . . . John von Newmann pointed out before his death, scientists are still unaware of the programming code that must exist within the brain."[8] Still others are also trying to duplicate the brain, for the "neurophysiologist Jerome Littven of M.I.T. has invented a single transistor network that behaves like a single neuron. By replacing transistors with Buck's or Shoulders' tiny switches, he hopes to make an electric neuron that is actually smaller than a human neuron."[9]

Still others are exploring different areas. "Frank Roenblatt, a young psychologist at Cornell Aeronautical Laboratory, is building an electric network that will recognize shape."[10] At the same time, "John McCarthy of MIT is devising a system of feeding computers declarative sentences for which it can create its own program"[11] and solve word problems. Added to these areas of exploration, we have a continual improvement in operations research techniques which means that complicated models of business problems can be solved by machine prior to expending the funds necessary to institute procedures throughout the organization. Add to these the remarkable advances being made in the science of solid state electronics as well as

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[8]Boehm, Fortune, March 1959, p. 148.

[9]Ibid., p. 150. [10]Ibid., p. 148. [11]Ibid.

advances in miniturization and it is possible to visualize how fast and vast the advancements in computer technology are going.

Thinking in terms of where we are and where we will probably be in the near future, we can visualize that the computerization of operational functions, which we have become accustomed to in the business world today, will expand into the management field. Looking closely at management we recognize that in decision making "the executive somehow combines his evaluation of different factors in a manner that leads to a decision."[12] This "somehow combines his evaluations" becomes the difficult area requiring programming if we can expect decisions to be aided by computers. However, it is possible to visualize programming, breakeven charts and other known management tools without too much difficulty. The result of such charts, coupled with marketing research by computers, inventory control, and other aids will certainly result in better decisions by management.

The development of computers for management will provide management with more information. "Information technology is likely to have its greatest impact on middle management, for just as planning was taken from the hourly worker and given to the industrial engineer, we now expect

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[12] R. K. Gaumnitz and O. H. Brownlee, "Mathematics for Decision-Makers," Administrative Control and Executive Action, ed. B. C. Lemke and James Don Edwards (Columbus, Ohio: Charles E. Merrill Books, Inc., 1961), p. 115.

it to be taken from middle managers."[13] As the specialists, probably some form of operation researchers assume more of middle managements roll in the business, we shall also see radical reorganization of businesses. The trend towards decentralization will be reversed and "we predict that large industrial organizations will recentralize, that top management will take on an even larger portion of the innovating, planning, and other creative functions than they have now."[14] Most of the remaining middle managers will be more of the technician type, since computers will provide top management with greater capacity to innovate, and produce more work.

As computers assume more of the responsibilities of the business, in determining marketing policies, "we doubt that many large companies in 1980's will be able to survive for even a decade without major changes, products, methods or internal organization."[15] This will lead to a greater effort in research and development and the creation of new products for us, the customers. Life will undergo many changes for all of us as we have things to use that effect us all in our daily lives.

As we watch big business expand more and more, pressures will be even greater on the little organization to use computers to survive. While it is known that through

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[13]Harold J. Leavitt and Thomas L. Whisler, "Management in the 1980's," Harvard Business Review, XXXVI, Vol. VI (November-December, 1958), p. 41.

[14]Ibid., p. 42. [15]Ibid., p. 46.

miniturization, as well as added know-how, manufacturers of computers are producing smaller units with increased capacity, small business is still at a dissadvantage. To cope with this problem we will witness the "banding together of small companies (enabling them to) reap all the benefits of a computer with none of the usual sky-high overhead.[16] Others, are obtaining the services without teaming up with others, instead they are using computer services supplied by independent concerns making a business of providing such service. In the future large and small businesses will be relying on computers in the business world in order to survive.

The future economic effects on our nation at this time are unpredictable, but it is a certainty that we will level out such economic fluctuations, as inventory builds up. Through computers we will have better and faster information as to inventory needs enabling inventory levels to follow more closely demand levels. We can also visualize that through use of the mechanization of principles of marketing, costing, budgeting, shipping and such things as breakeven charts we shall have more economical control of each business function within the business world. Add to this automation of labors work and we see that man's productive capabilities at all levels will increase many fold. Insert our population growth and man will have to do less work than before and be paid more to maintain living

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[16]"Computers for Everybody," Dun's Review and Modern Industry, December, 1961, p. 42.

standards. However the unemployment problem will become even a more serious problem for tomorrow's economists than today.

When one thinks in terms of the politicians using computers to determine how to win elections, what to say to whom, etc. we can picture one candidate's campaign being countermanded by his opposition's computer, we can see that the destiny of our national political future may rest in the hands of computers.

Our safety from aggression of others is largely in the hands of the world power play of diplomats. It is a simple matter to expand our thoughts to the international arena and visualize computers of nations competing with each other for world domination. The victors of this struggle might well be those that have developed further in computer technology.

Even today, our military men use computers for logistic and strategy problems. Gaming is common among military leaders in working out the details of massive war games in the matter of hours or days instead of weeks or months as previously required. Even aboard our combat ships we are incorporating computers that do "the calculating and plotting without delays."[17]

In summary we can see that in almost every walk

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[17]John A. Chastain, "The Role of Computers in Combat Control," U. S. Naval Institute Proceedings, September, 1961, p. 59.

of life, from scientists to lawyers, labor to the business executive, politician to military, computers have an important position. It is little wonder that as computers grow in their importance to mankind, and as computers struggle to influence mankind, the moral side of man will demand new answers to religious beliefs. Therefore, it is conceivable that religious leaders will themselves turn to computers for aid in satisfying man's demands.

This revolution of computers for man's mind and their growing ability to "think" will not come about gracefully. Our ways of living will be upset, our traditional outlook will be upset, and in many instances our jobs will change. The problems of "resistance to change will occur among those . . . who are programmed out of their . . . current status . . . and possibly out of their jobs."[18] But it may not be all bad, for the future will have many changes, both good and bad. The computer may in the long run solve man's age old problem of war, and we may well live, for the first time in history, in a world free of war. After all, man's complexity has never been understood, and so differences had to be settled through conflict . . . maybe the capability of the computer is our answer.

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[18]Leavit and Whisler, Harvard Business Review, November-December, 1958, p. 44.

CONCLUSIONS

Automatic Data Processing is a technique which only the foolhardy management would ignore. It is a tool which, like all tools, must be appraised for proper use and application. Ill used it results in pyramiding administrative and capital cost to the detriment of profit. Properly used it provides a workmanlike product which generates reward. It is not a replacement for management decision, rather, it is an adjunct to effective management.

Knowledge of the potential and the weakness of automatic data processing is essential to the executive. The impact of this equipment on people, on the organization and upon management itself is no less than the impact of any other mechanization. This requires discrete, planned, and organized effort to turn to corporate advantage. The planning of such an installation requires reasoned analysis and feasibility study. To select ADP by emotion or envy is to invite misfortune. By the same token the use of such equipment requires mature continuing management to optimize operating and administrative expense, to fully profit by the personnel advantages possible and to derive accelerated management actions from the speed of automated reporting.

The future of ADP will be more of the past. Rapid technological evolution, accelerated application, and new techniques. The need is to know ADP, to apply it, and to grow with it, but most of all to use it for our purpose. This use will continue to be most effective when it emphasizes the human side of automation.

APPENDIX

GLOSSARY OF COMPUTER TERMINOLOGY

Based on Definition of terms by the Radio Corporation of America and IBM.

ACCELERATION TIME: Time required to get magnetic tape up to normal or operating speed.

ACCESS TIME: Time required to take, put or storage information from or to a storage device.

ACCUMULATOR: A storage device in the main computer which holds the results of arithmetic operations. Often can add together if desired the number it holds.

ADDER: A device which adds two quantities delivered to it.

ADDRESS: The label identifying storage location of information, or providing the location which information is to be stored.

ANALOG COMPUTER: Calculating devices which operate by measuring physical quantities such as the rotation of a shaft or changes in line voltage.

ARITHMETIC UNIT: The part of the unit which contains the circuits for performing arithmetic operations.

AUTOMATIC PROGRAMMING SYSTEM: A method whereby programming can be achieved by the computer itself, taking a non computer program and translating it by the machine into a computer program.

CENTRAL PROCESSING UNIT: That group of components which contain the arithmetic, logical and control circuits for the system. It may also contain the storage unit and operators console.

CONSOLE: That component of the system which provides manual control and observation of the system.

CONTROL UNIT: That component that contains the circuits and devices which govern overall or a portion of the operation.

DIGITAL COMPUTER: A device which processes numbers or information in a digital form.

EDIT: To rearrange data.

ERASE: To destroy stored data.

FLOW CHART: Graphic presentation of the flow of data or information through a sequence of operations in a program, using symbols to represent varicus operations.

HOUSEKEEPING: Instructions which are used to set up a program.

INDEXING: A method of modifying automatically the address of information.

INDICATOR: A light or tone, usually associated with the console, to indicate that a particular condition has occurred in the computer.

INITIALIZE: To set a condition, routine or word to its original state.

INPUT: Information taken into the internal storage of the computer.

INPUT AREA: That part of storage provided to receive information.

INSTRUCTION: Characters or symbols, usually not in machine language, which when interpreted by the control unit, results in the data processing system to operate.

MAGNETIC DRUM: A rotating cylinder, on whose coated surface information may be recorded as small magnetic spots representing binary information.

MAGNETIC TAPE: Plastic tape, coated with a metallic material, on which data may be recorded in the form of magnetic spots.

MAGNETIC CORE: A small ferromagnetic material either doughnut or straight shape capable of storing one binary digit, represented by the polarity of its magnetic field.

MICROSECOND: One millionth of a second.

MILLISECOND: One thousandth of a second.

OCTAL SYSTEM: A numbering system using base eight.

OFF LINE: Operations carried on independently of the main computer.

ON LINE: Operations carried on within the main computer system.

OUTPUT: Information transferred from within the computer to any external device or to external or secondary storage.

PROGRAM: Sequence instructions which causes the computer to process a specific application.

RANDOM ACCESS STORAGE: A storage device where access to the information is in no way dependent on the position from which information was previously obtained.

RECORD: The data contained between two identifying spots.

REGISTER: A device capable of retaining information.

RUN: A term meaning the performance of one program on a computer.

STORAGE: Any device in which information can be retained for later use.

UPDATE: To search, select a single entry, perform an operation with it and then replace it in the file.

WORD: Characters which occupy a single storage location which are treated as a unit.

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